μRTube

a new geometry concept for MPGD technologies

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Motivation

The basic idea is to develop a **tubular MPGD** working as a radial TPC: the readout on the inner cylinder and the cathode on the outer one.

The signal is **amplified** by a μRWELL as a single stage amplification and the readout is instrumented with strips parallel to the axis.

The main concept of the project is based on the convergent electrical field lines which introduce two important points:

1. it reduces the transverse diffusion of the electrons
2. it **minimizes the number of channels** with respect to the sensitive volume

Innovation

PCB and amplification stages used in MPGD can be shaped to cylinders; examples are the triple-GEM for the IT in **KLOE-2** and **BESIII**, and the μRWELL for **EURIZON**

Curvature radius in literature ranges from 77 mm to 205 mm.
μRWELL technology, with a single stage of amplification, has an easier construction.

The shapeability of the MPGD is the initial driver of the μRtube idea

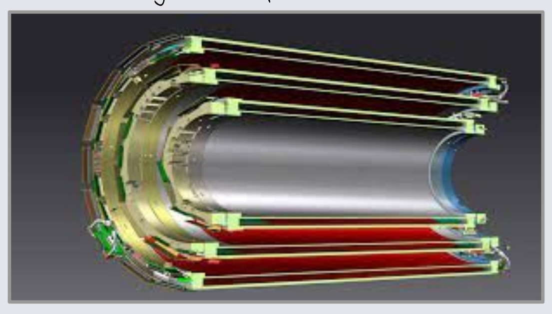
The μRWELL is a Micro Pattern Gaseous Detector (MPGD) composed of only two elements: the μRWELL-PCB and the cathode. The core is the μRWELL-PCB, realized by coupling three different elements:

1. a WELL patterned kapton foil acting as amplification stage (GEM-like)
2. a resistive DLC layer (Diamond-Like-Carbon) for discharge suppression with surface resistivity ~ 100 MΩ/□
3. a standard readout PCB

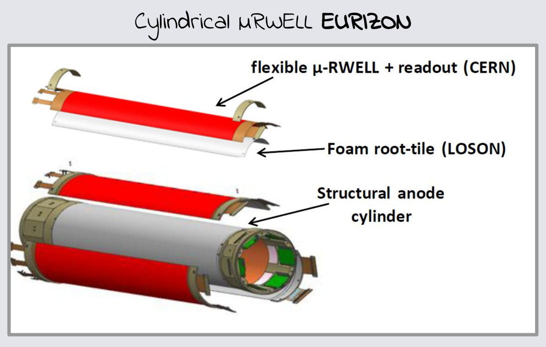
The construction technique is simplified with respect to GEM or MicroMegas and it is suitable for compact and flexible detectors.

Cylindrical triple-GEM KLOE-2

Cylindrical triple-GEM BESIII

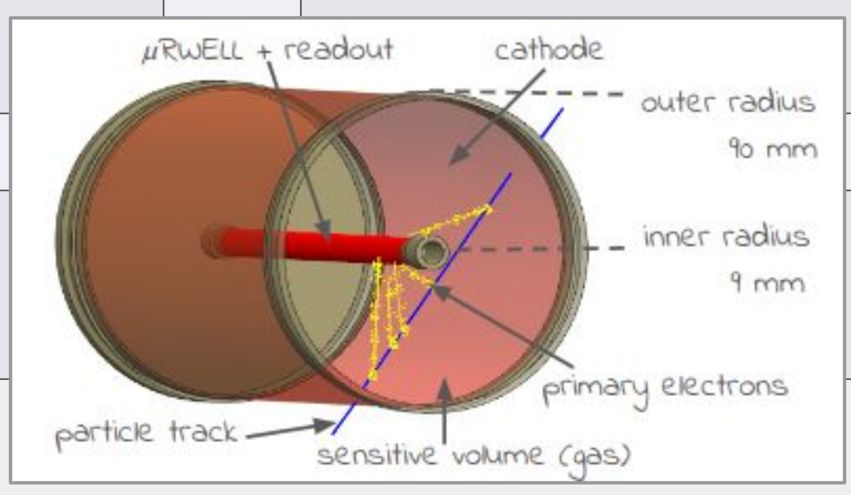


Cylindrical μRWELL EURIZON



Bencivenni et al. | Balossino et al. | See G. Morello poster PM2024

Methodology

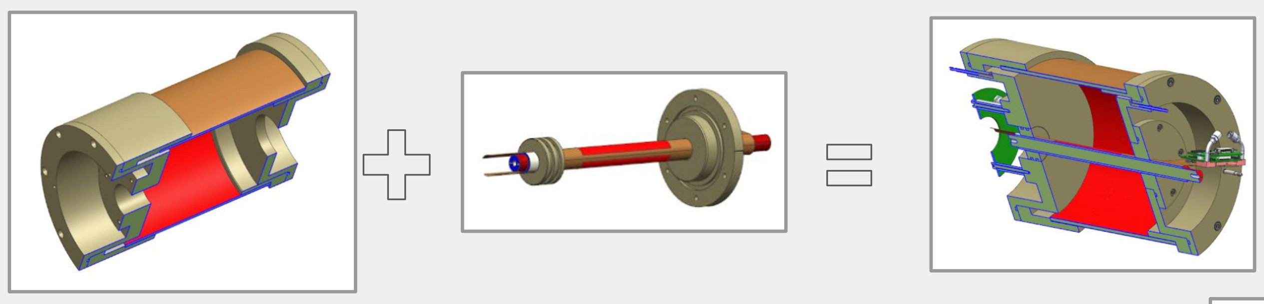


Mechanics

The main challenge of this project is to shape a μRWELL at this unprecedented **curvature radius of 9mm.** Using a flexible PCB approximately 150μm thick, a specific procedure can be employed to achieve success without causing damage to the amplification stage.

The mechanical support of the cathode is built up by a **fiberglass, kapton and honeycomb sandwich. Flanges** will seal the gas volume and provide the support for the services (gas, HV, FEB) are built by **PEEK.**

The detector will be **easily open** in case of failure of the component or replacement of the cathode/readout. μRtube have cleaned successfully by CERN MPGD workshop (Rui).

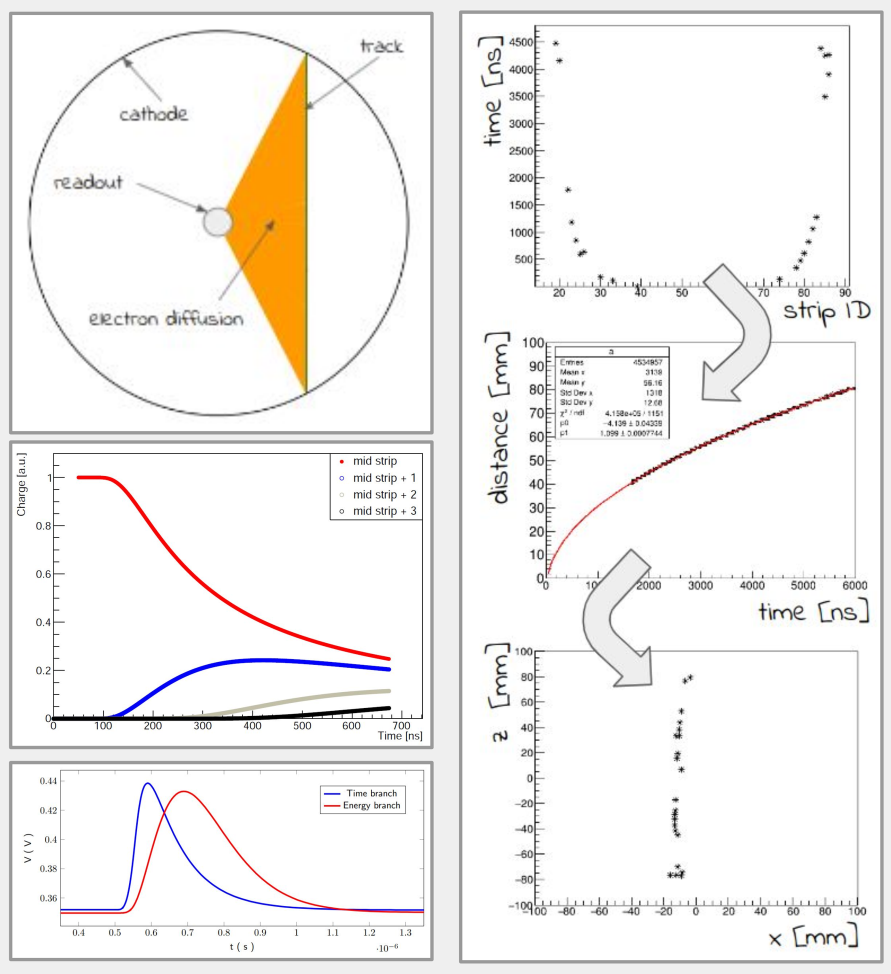


Simulation

A full complete simulation consist of a **parametric** description of the **detector response** thats includes the detector **geometry** and the **signal** reconstruction.

The full simulation is divided in different physical processes. The μRWELL parametrization with **PARSIFAL** is been presented in previous RD51 collaboration meeting.

To achieve the complete μRtube simulation, the new electron drift parametrization and new electronics (TIGER) are implemented.



Farinelli et al.

Electronics

The full readout chain used exploit the TIGER electronics and the GEMROC FPGA developed within BESIII for the CGEM-IT.

TIGER chip features:

- 64 channels
- Event rate 100 kHz/channel
- Input dynamic range up to 50 fC
- Time resolution < 5 ns
- ENC < 2000 e⁻ rms with 100 pF input capacitance

Amoroso et al. | See S. Gramigna poster PM2024

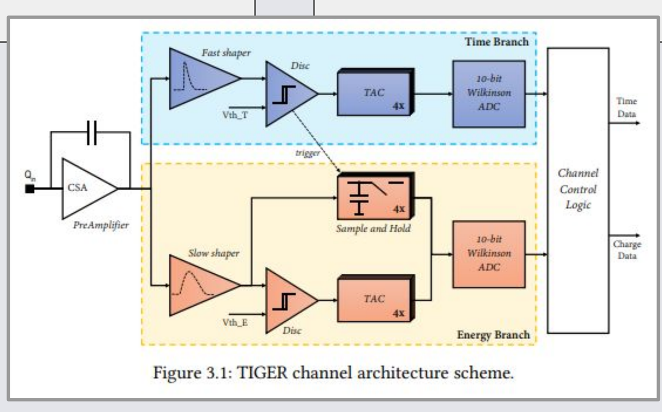
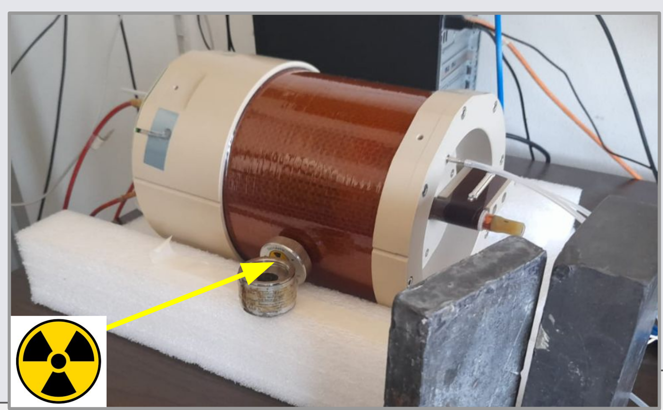
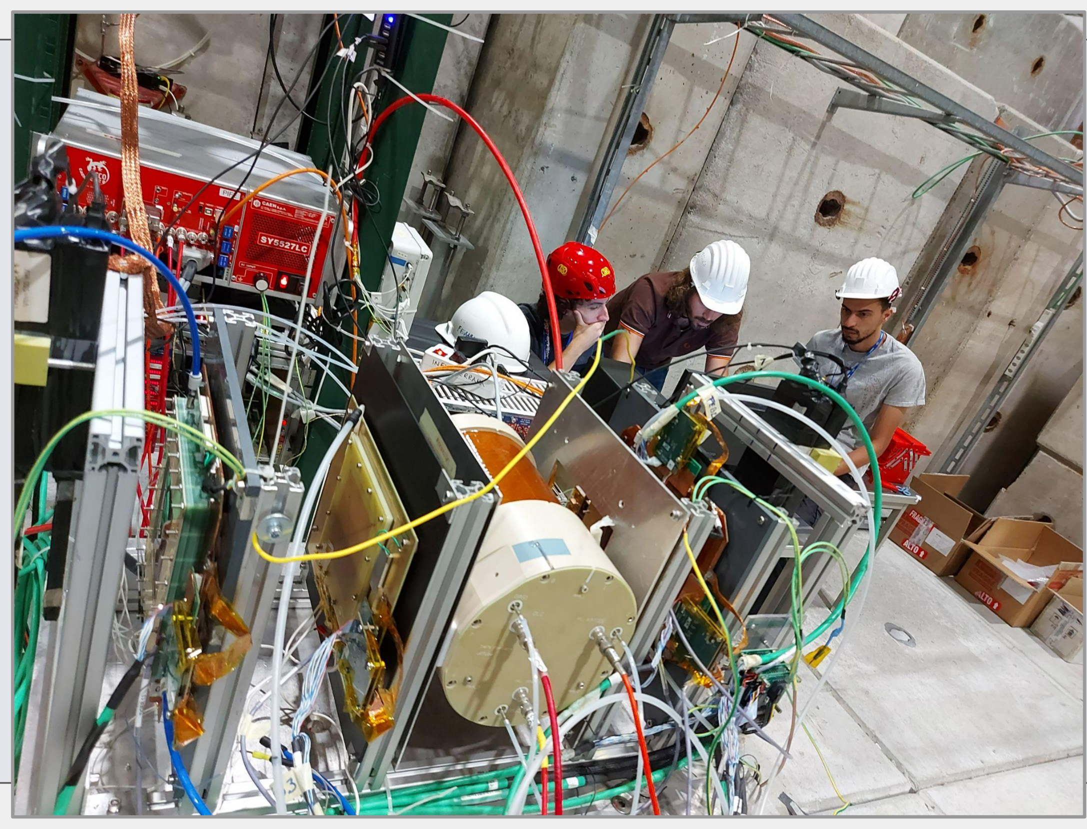


Figure 3.1: TIGER channel architecture scheme.



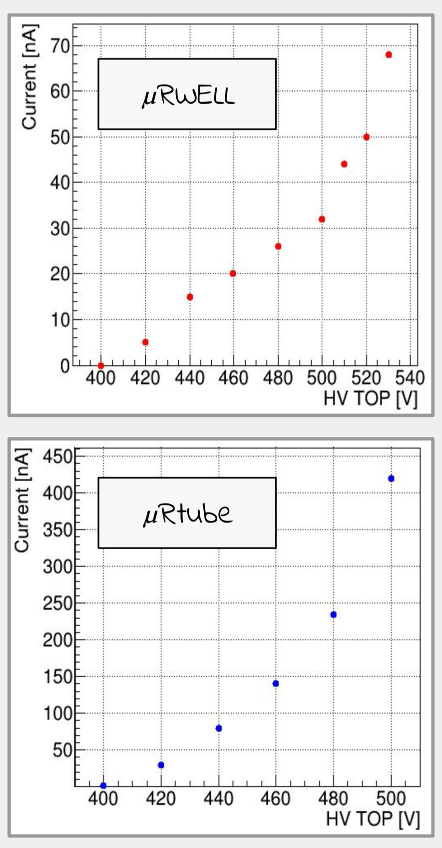


Radioactive source

A Sr 90 beta source with 4 MBq has been used to test the detector. Thank to the high activity of the source, it is possible to measure the detector gain with a leakage current measurement. The same test has been performed on planar μRWELL and μRtube.

The data show a much higher current in μRtube due to a the larger ionization volume.

The test shown the good operation of the amplification stage after the tubular shaping.



Test beam

During the RD51 **testbeam**, h4 line at CERN North-area, a μRTube is tested together with a tracking system. TIGER threshold set lower than 0.5 fC.

Two scans performed:

- Drift Field [0V - 5000V]
- HV scan [400V - 540V]

The spatial resolution is of about 1 mm for the single strip but calibration are still needed to improve the resolution of the full detector.